Phasor approach to fluorescence lifetime microscopy distinguishes different metabolic states of germ cells in a live tissue.

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Public Summary:
We describe a label-free imaging method to monitor stem-cell metabolism that discriminates different states of stem cells as they differentiate in living tissues. In live tissues we are able to identify intrinsic fluorophores, such as collagen, retinol, retinoic acid, porphyrin, flavins, and free and bound NADH. We have exploited this approach to detect a trend in metabolite concentrations along the main axis of the Caenorhabditis elegans germ line. This trend is consistent with known changes in metabolic states during differentiation. The cell phasor approach to lifetime imaging provides a label-free, fit-free, and sensitive method to identify different metabolic states of cells during differentiation, to sense small changes in the redox state of cells, and may identify symmetric and asymmetric divisions and predict cell fate. Our method is a promising noninvasive optical tool for monitoring metabolic pathways during differentiation or disease progression, and for cell sorting in unlabeled tissues.

Scientific Abstract:
We describe a label-free imaging method to monitor stem-cell metabolism that discriminates different states of stem cells as they differentiate in living tissues. In this method we use intrinsic fluorescence biomarkers and the phasor approach to fluorescence lifetime imaging microscopy in conjunction with image segmentation, which we use to introduce the concept of the cell phasor. In live tissues we are able to identify intrinsic fluorophores, such as collagen, retinol, retinoic acid, porphyrin, flavins, and free and bound NADH. We have exploited the cell phasor approach to detect a trend in metabolite concentrations along the main axis of the Caenorhabditis elegans germ line. This trend is consistent with known changes in metabolic states during differentiation. The cell phasor approach to lifetime imaging provides a label-free, fit-free, and sensitive method to identify different metabolic states of cells during differentiation, to sense small changes in the redox state of cells, and may identify symmetric and asymmetric divisions and predict cell fate. Our method is a promising noninvasive optical tool for monitoring metabolic pathways during differentiation or disease progression, and for cell sorting in unlabeled tissues.

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